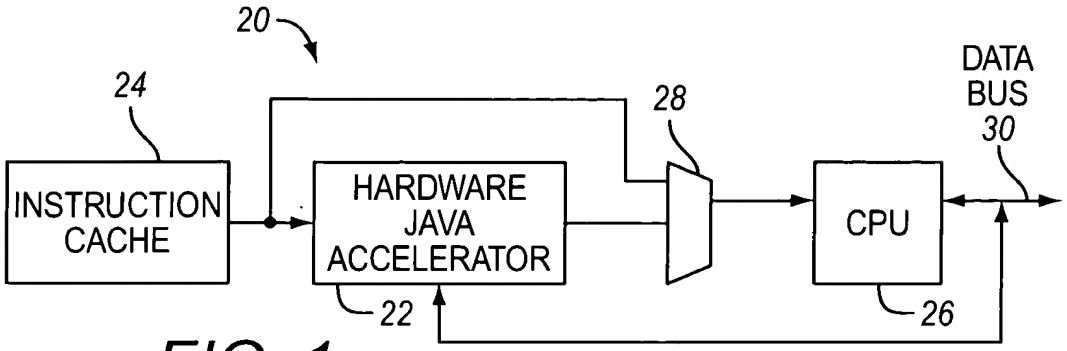



FIG. 1

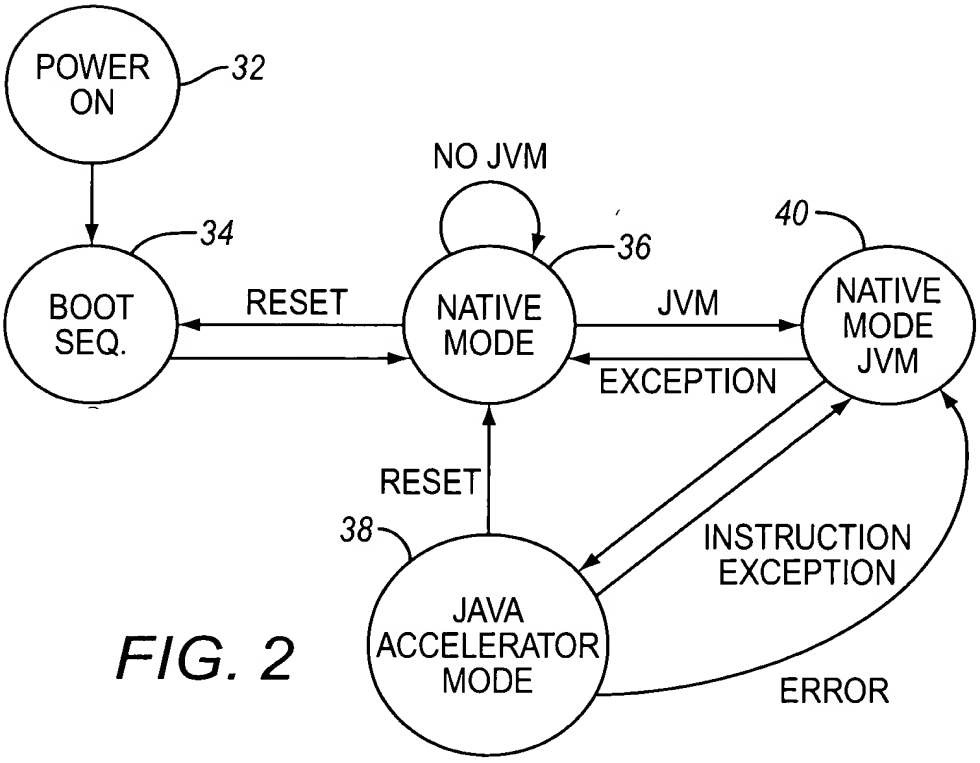



FIG. 2

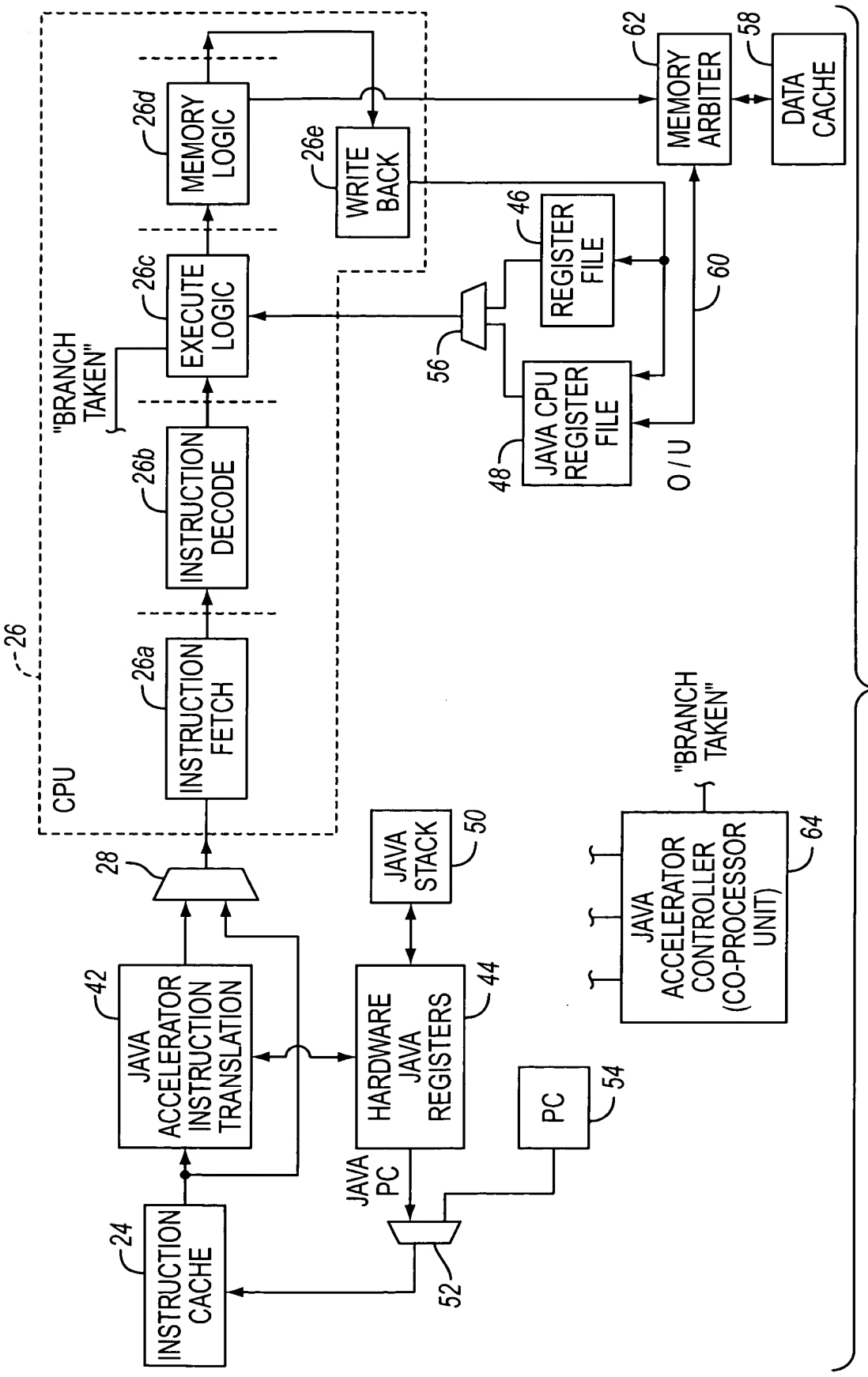



FIG. 3

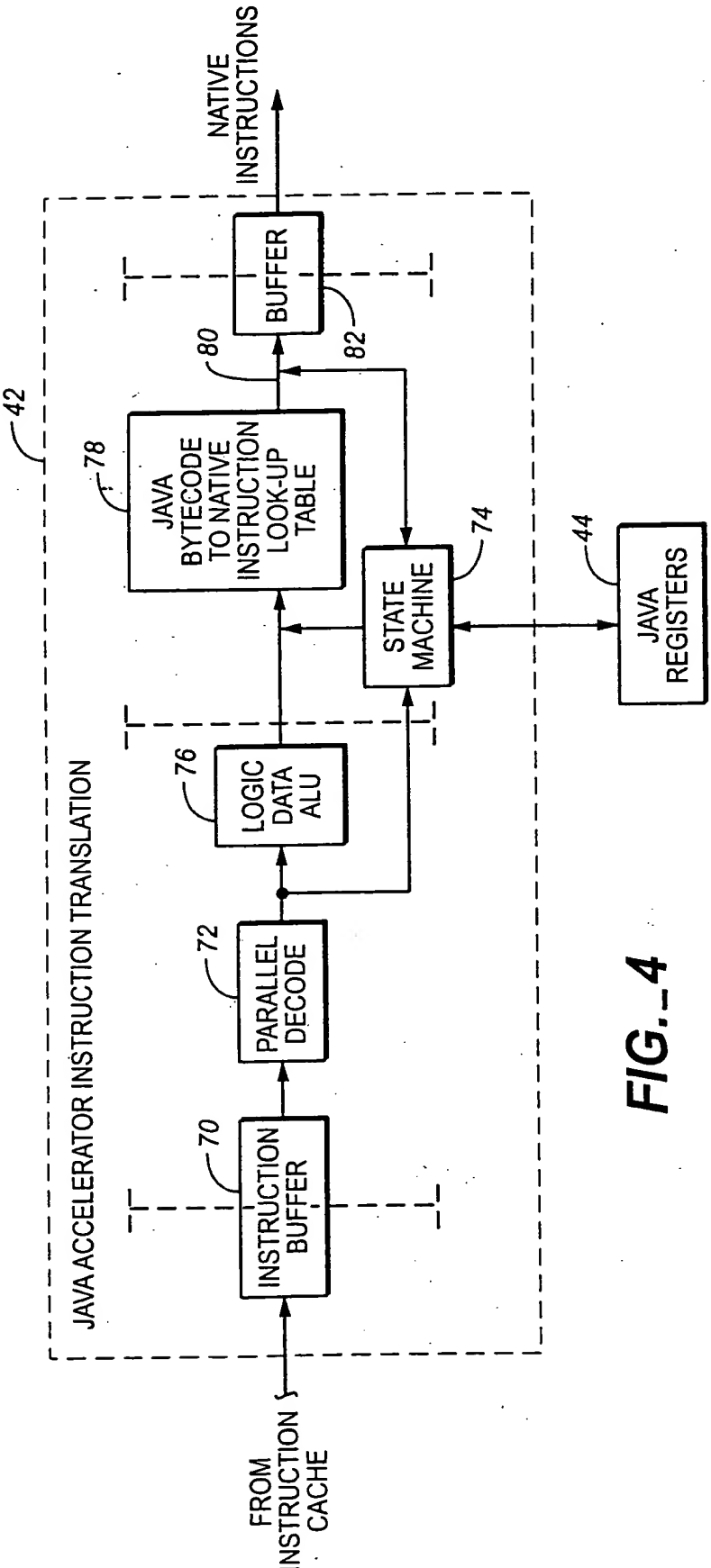



FIG._4

I. INSTRUCTION TRANSLATION

| JAVA BYTECODE | | NATIVE INSTRUCTION |
|---|---|---|
| iadd | ⇨ | ADD R1, R2 |

II. JAVA REGISTER

| | | |
|---|---|---|
| PC = VALUE A | ⇨ | PC = VALUE A + 1 |
| OPTOP = VALUE B (R1) | | OPTOP = VALUE B - 1 (R2) |
| VAR = VALUE C | | VAR = VALUE C |

III. JAVA CPU REGISTER FILE

| | | | | | |
|---|---|---|---|---|---|
| | R0 | 0001 | | R0 | 0001 |
| CONTAINS VALUE OF TOP OF OPERAND STACK → | R1 | 0150 | ⇨ NOT A VALID STACK VALUE → | R1 | 0150 |
| | R2 | 1210 | CONTAINS VALUE OF THE TOP OF OPERAND STACK → | R2 | 1360 |
| | R3 | 0007 | | R3 | 0007 |
| | R4 | 0005 | | R4 | 0005 |
| | R5 | 0006 | | R5 | 0006 |
| CONTAINS FIRST VARIABLE → | R6 | 1221 | | R6 | 1221 |
| | R7 | 1361 | | R7 | 1361 |

IV. MEMORY

| | | | | | |
|---|---|---|---|---|---|
| OPTOP = VALUE B → | - | 0150 | | - | 0150 |
| (VALUE B - 1) | - | 1210 | ⇨ OPTOP = VALUE B - 1 | - | 1360 |
| | - | 0007 | | - | 0007 |
| | - | 0005 | | - | 0005 |
| | - | 0006 | | - | 0006 |
| | - | 0001 | | - | 0001 |
| | - | 4427 | | - | 4427 |
| VAR = VALUE C | - | 1221 | VAR = VALUE C | - | 1221 |
| | - | 1361 | | - | 1361 |
| | - | 1101 | | - | 1101 |

FIG._5

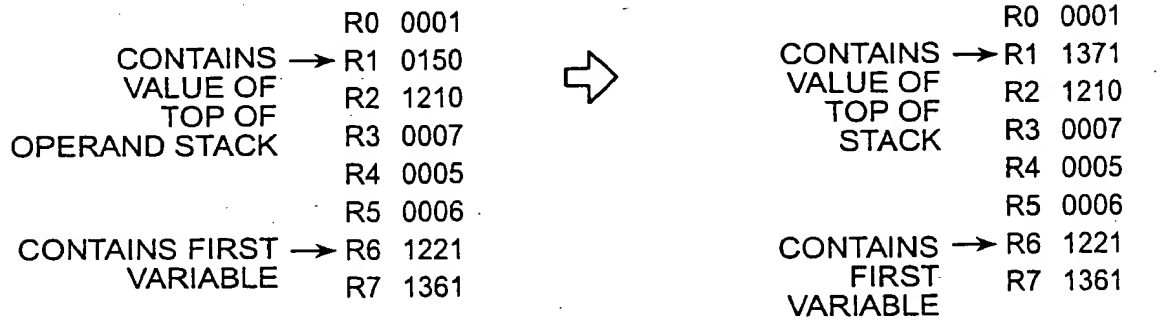
I. INSTRUCTION TRANSLATION

| JAVA BYTECODE | | NATIVE INSTRUCTION |
|---|---|---|
| iload_n<br>iadd | ⇨ | ADD R6, R1 |

II. JAVA REGISTER

| | | |
|---|---|---|
| PC = VALUE A<br>OPTOP = VALUE B (R1)<br>VAR = VALUE C | ⇨ | PC = VALUE A + 2<br>OPTOP = VALUE B (R1)<br>VAR = VALUE C |

III. JAVA CPU REGISTER FILE




IV. MEMORY

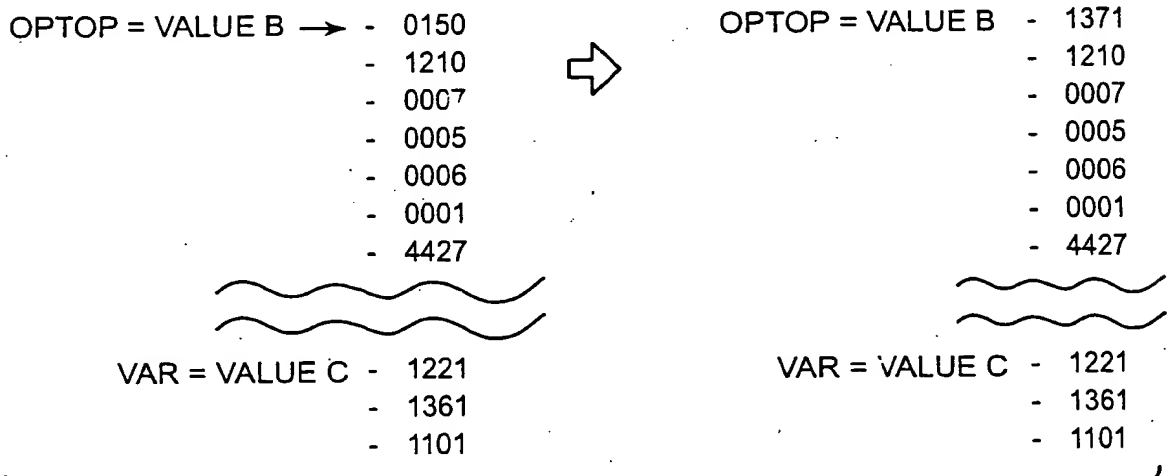



FIG._6

| Opcodes Mnemonic | Opcode xHH | Excep Gen |
|---|---|---|
| | | |
| nop | 0x00 | |
| aconst_null | x01 | |
| iconst_m1 | x02 | |
| iconst_n(0-5) | x03 - x08 | |
| lconst_n(0-1) | x09 - x0a | |
| fconst_n(0-2) | x0c - x0d | |
| dconst_n(0-1) | x0e -x0f | |
| bipush | x10 | |
| sipush | x11 | |
| ldc | x12 | y |
| ldc_w | x13 | y |
| ldc2_w | x14 | y |
| iload | x15 | |
| lload | x16 | |
| fload | x17 | |
| dload | x18 | |
| aload | x19 | |
| iload_n(0-3) | x1a - x1d | |
| lload_n(0-3) | x1e - x21 | |
| fload_n(0-3) | x22 - x25 | |
| dload_n(0-3) | x26 - x29 | |
| aload_n(0-3) | x2a - x2d | |
| iaload | x2e | |
| laload | x2f | |
| faload | x30 | |
| daload | x31 | |
| aaload | x32 | |
| baload | x33 | |
| caload | x34 | |
| saload | x35 | |
| istore | x36 | |
| lstore | x37 | |
| fstore | x38 | |
| dstroe | x39 | |
| astroe | x3a | |
| istore_n(0-3) | x3b - x3e | |
| lstore_n(0-3) | x3f - x42 | |
| fstore_n(0-3) | x43 - x46 | |
| dstore_n(0-3) | x47 - x4a | |
| astore_n(0-3) | x4b - x4e | |
| iastore | x4f | |
| lastore | x50 | |
| fastroe | x51 | |
| dastore | x52 | |
| bastore | x53 | |
| aastore | x54 | |
| castroe | x55 | |
| sastore | x56 | |

FIG._7A

| | | |
|---|---|---|
| pop | x57 | |
| pop2 | x58 | |
| dup | x59 | |
| dup_x1 | x5a | |
| dup_x2 | x5b | |
| dup2 | x5c | |
| dup2_x1 | x5d | |
| dup2_x2 | x5e | |
| swap | x5f | |
| iadd | x60 | |
| ladd | x61 | |
| fadd | x62 | y |
| dadd | x63 | y |
| isub | x64 | |
| lsub | x65 | |
| fsub | x66 | y |
| dsub | x67 | y |
| imul | x68 | |
| lmul | x69 | |
| fmul | x6a | y |
| dmul | x6b | y |
| idiv | x6c | y |
| ldiv | x6d | y |
| fdiv | x6e | y |
| ddiv | x6f | y |
| irem | x70 | y |
| lrem | x71 | y |
| frem | x72 | y |
| drem | x73 | y |
| ineg | x74 | |
| lneg | x75 | |
| fneg | x76 | y |
| dneg | x77 | y |
| ishl | x78 | |
| lshl | x79 | |
| ishr | x7a | |
| lshr | x7b | |
| iushr | x7c | |
| lushr | x7d | |
| iand | x7e | |
| land | x7f | |
| ior | x80 | |
| lor | x81 | |
| ixor | x82 | |
| lxor | x83 | |
| iinc | x84 | |
| i2l | x85 | y |
| i2f | x86 | y |
| i2d | x87 | y |
| l2i | x88 | y |
| l2f | x89 | y |
| l2d | x8a | y |

FIG._7B

| | | |
|---|---|---|
| f2i | x8b | y |
| f2l | x8c | y |
| f2d | x8d | y |
| d2i | x8e | y |
| d2l | x8f | y |
| d2f | x90 | y |
| i2b | x91 | |
| i2c | x92 | |
| i2s | x93 | |
| lcmp | x94 | y |
| fcmpl | x95 | y |
| fcmpg | x96 | y |
| dcmpl | x97 | y |
| dcmpg | x98 | y |
| ifeq | x99 | |
| ifne | x9a | |
| iflt | x9b | |
| ifge | x9c | |
| ifgt | x9d | |
| ifle | x9e | |
| if_icmpeq | x9f | |
| if_icmpne | xa0 | |
| if_icmplt | xa1 | |
| if_acmpge | xa2 | |
| if_cmpgt | xa3 | |
| if_icmple | xa4 | |
| if_acmpeq | xa5 | |
| if_acmpne | xa6 | |
| goto | xa7 | |
| jsr | xa8 | |
| ret | xa9 | |
| tableswitch | xaa | y |
| lookupswitch | xab | y |
| ireturn | xac | |
| lreturn | xad | |
| freturn | xae | |
| dreturn | xaf | |
| areturn | xb0 | |
| return | xb1 | |
| getstatic | xb2 | y |
| putstatic | xb3 | y |
| getfield | xb4 | y |
| putfield | xb5 | y |
| invokevirtual | xb6 | y |
| invokespecial | xb7 | y |
| invokestatic | xb8 | y |
| invokeinterface | xb9 | y |
| xxunsedxxx | xba | y |
| new | xbb | y |
| newarray | xbc | y |
| anewarray | xbd | y |
| arraylength | xbe | y |

FIG._7C

| athrow | xbf | y |
|---|---|---|
| checkcast | xc0 | y |
| instanceof | xc1 | y |
| monitorenter | xc2 | y |
| monitorexit | xc3 | y |
| wide | xc4 | y |
| multianewarray | xc5 | y |
| ifnull | xc6 | y |
| ifnonnull | xc7 | y |
| goto_w | xc8 | |
| jsr_w | xc9 | |
| | | |
| | | |
| ldc_quick | xcb | y |
| ldc_w_quick | xcc | y |
| ldc2_w_quick | xcd | y |
| getfield_quick | xce | y |
| putfield_quick | xcf | y |
| getfield2_quick | xd0 | y |
| putfield2_quick | xd1 | y |
| getstatic_quick | xd2 | y |
| putstatic_quick | xd3 | y |
| gtestatic2_quick | xd4 | y |
| putstatic2_quick | xd5 | y |
| invokevirtual_quick | xd6 | y |
| invokenonvirtual_quick | xd7 | y |
| invokesuper_quick | xd8 | y |
| invokestatic_quick | xd9 | y |
| invokeinterface_quick | xda | y |
| invokevirtualobject_quick | xdb | y |
| new_quick | xdc | y |
| anewarray_quick | xde | y |
| multinewarray_quick | xdf | y |
| checkcast_quick | xe0 | y |
| instanceof_quick | xe1 | y |
| invokevirtual_quick_w | xe2 | y |
| getfield_quick_w | xe3 | y |
| putfield_quick_w | xe4 | y |
| | | |
| | | |
| breakpoint | xca | y |
| impdep1 | xfe | y |
| impdep2 | xff | y |

FIG._7D

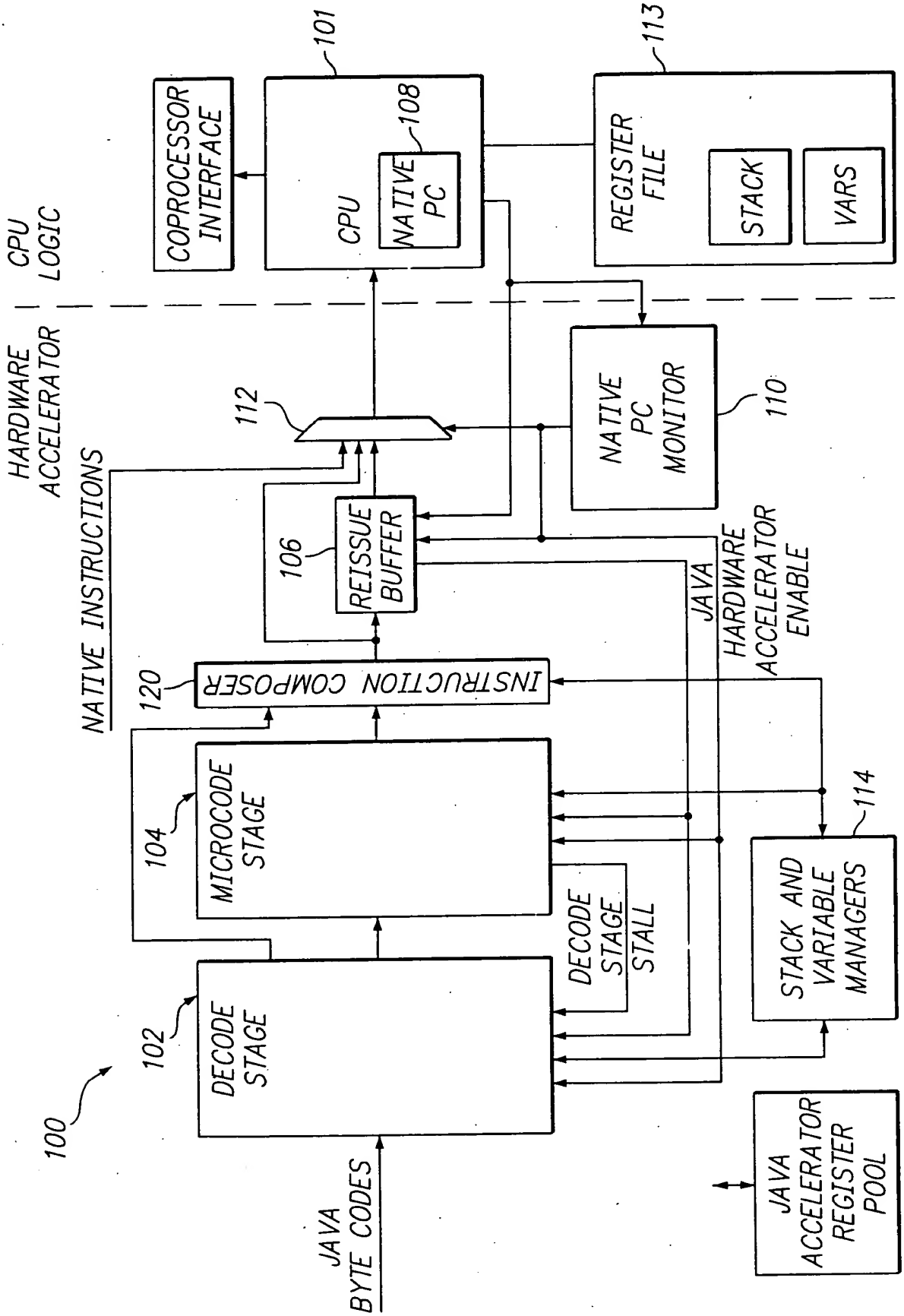



FIG. 8

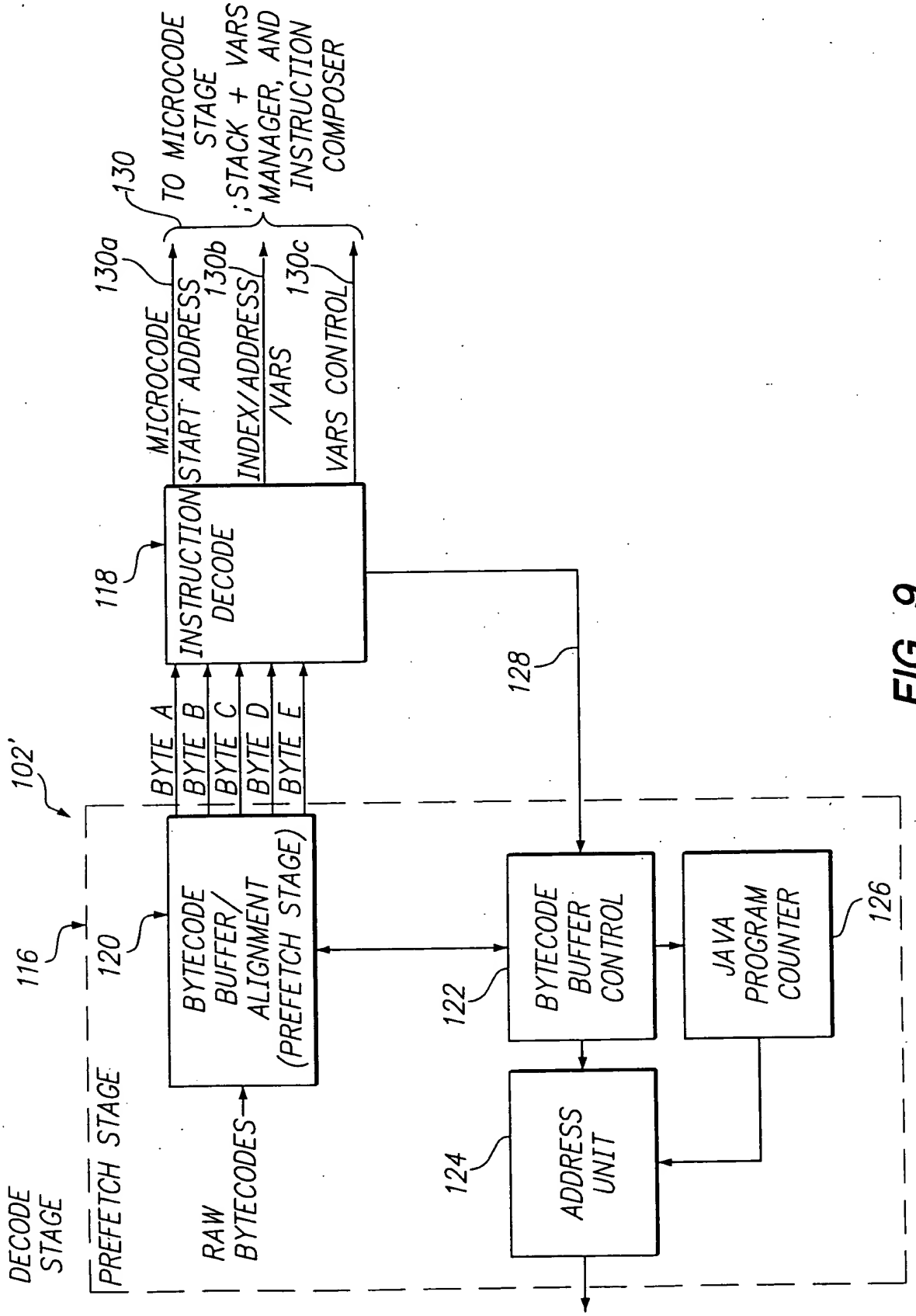



FIG. 9

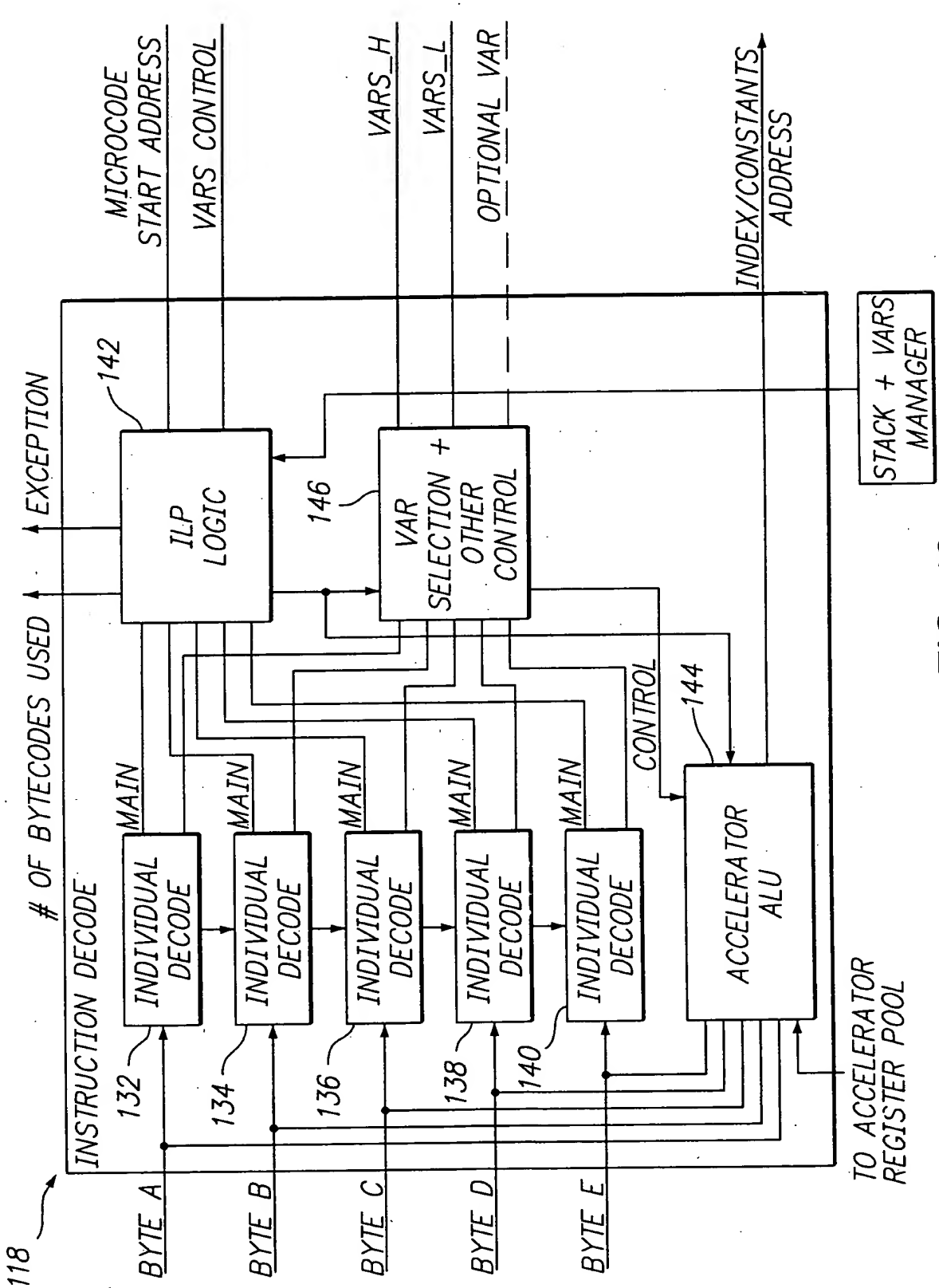



FIG. 10

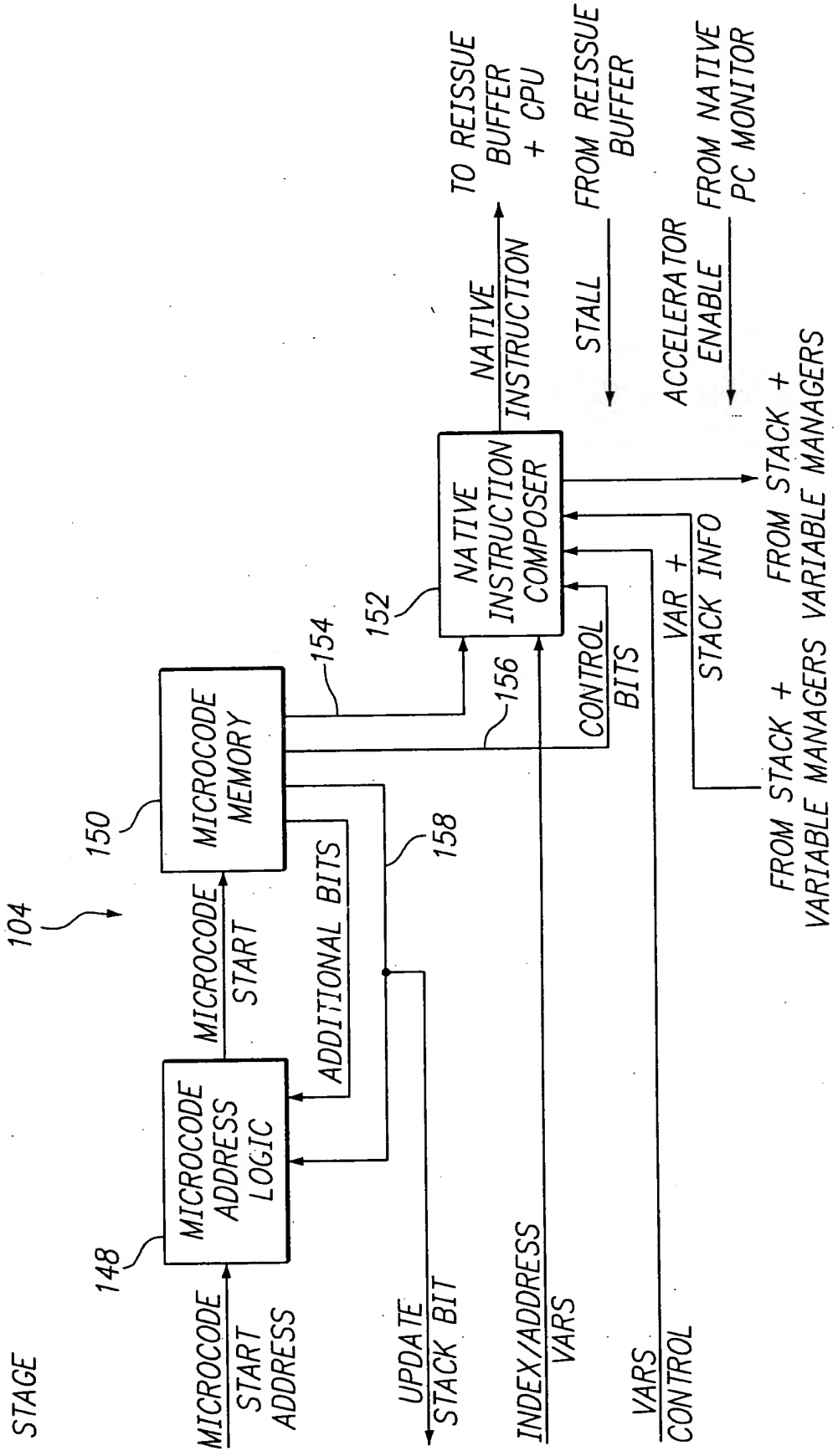



FIG. 11

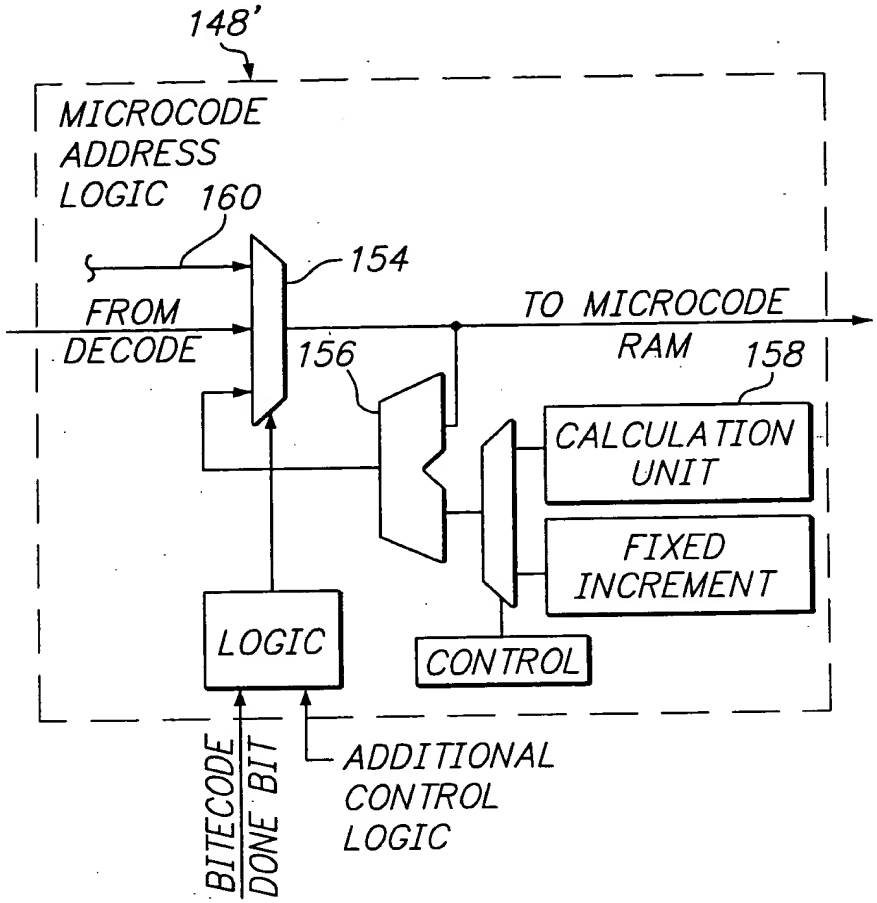



FIG. 12

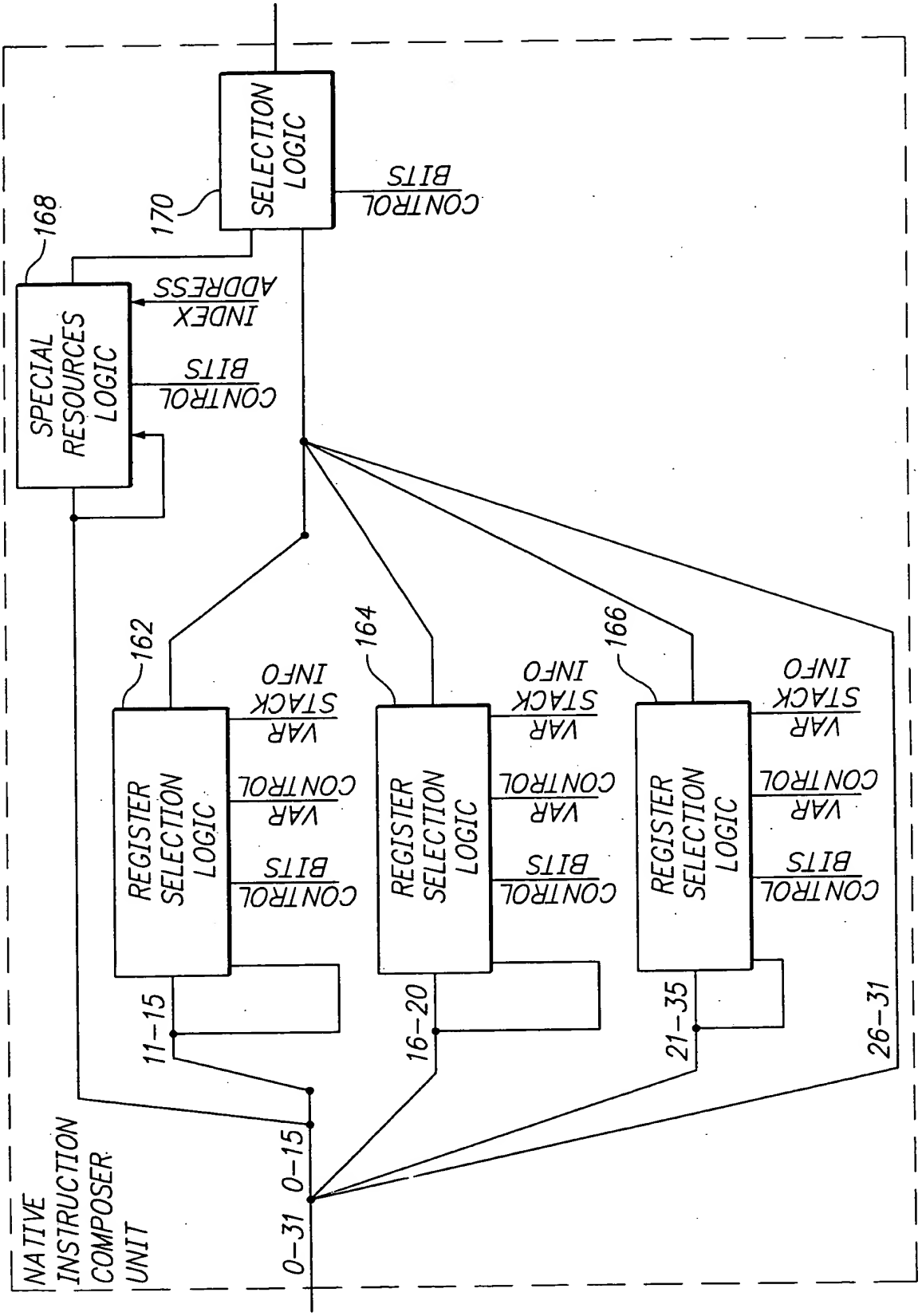



FIG. 13

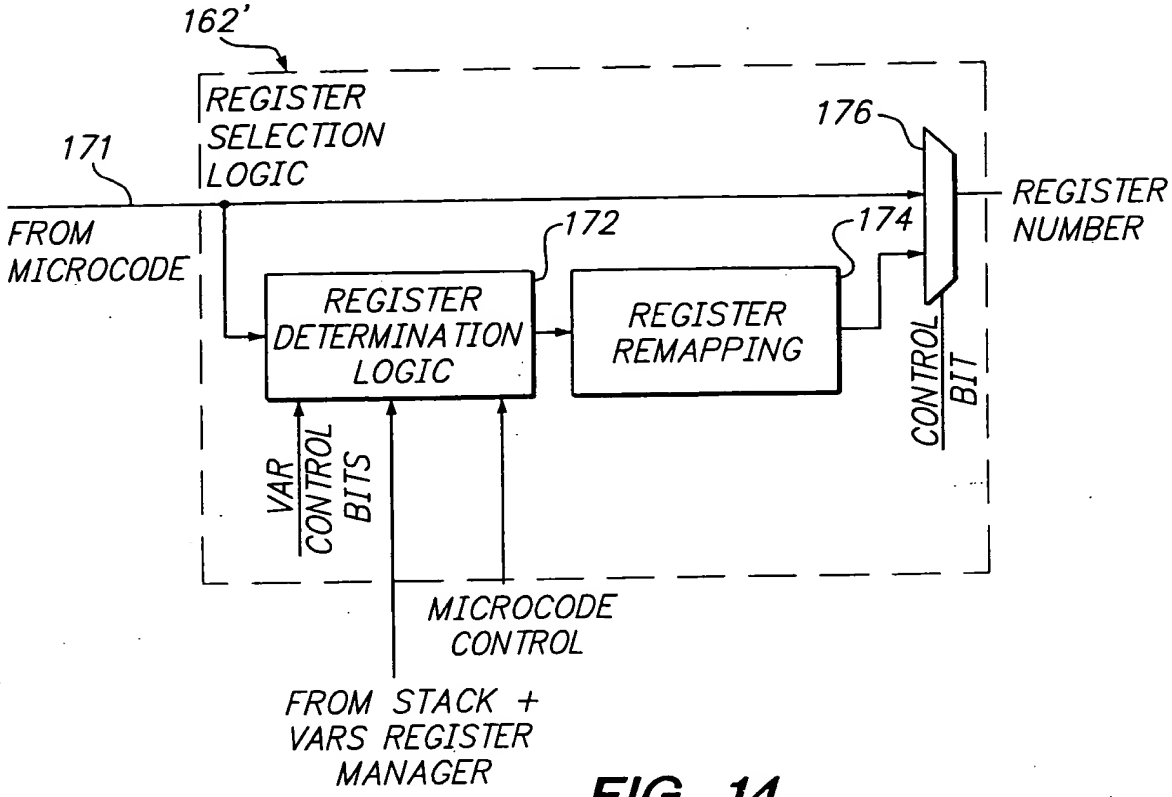



FIG. 14

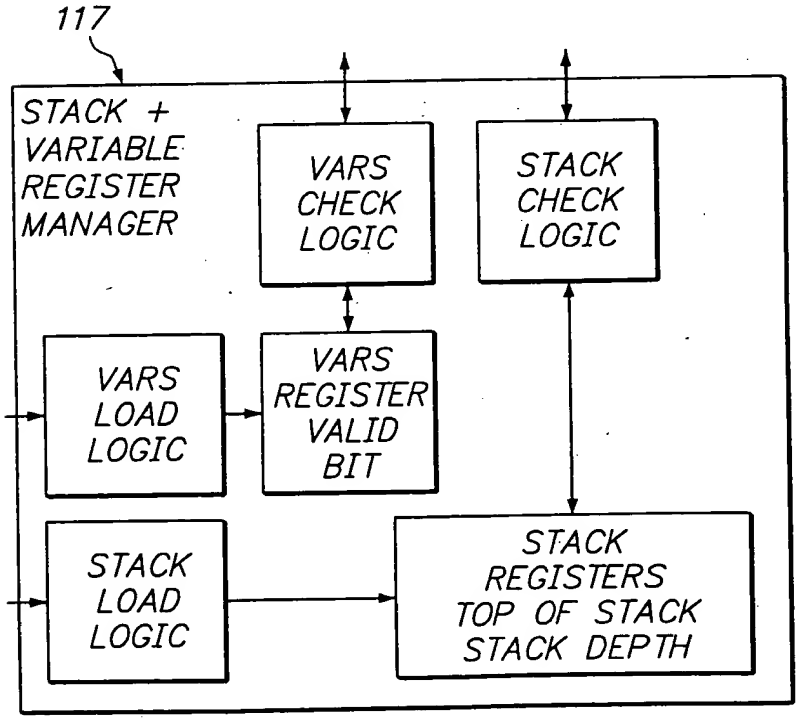



FIG. 15

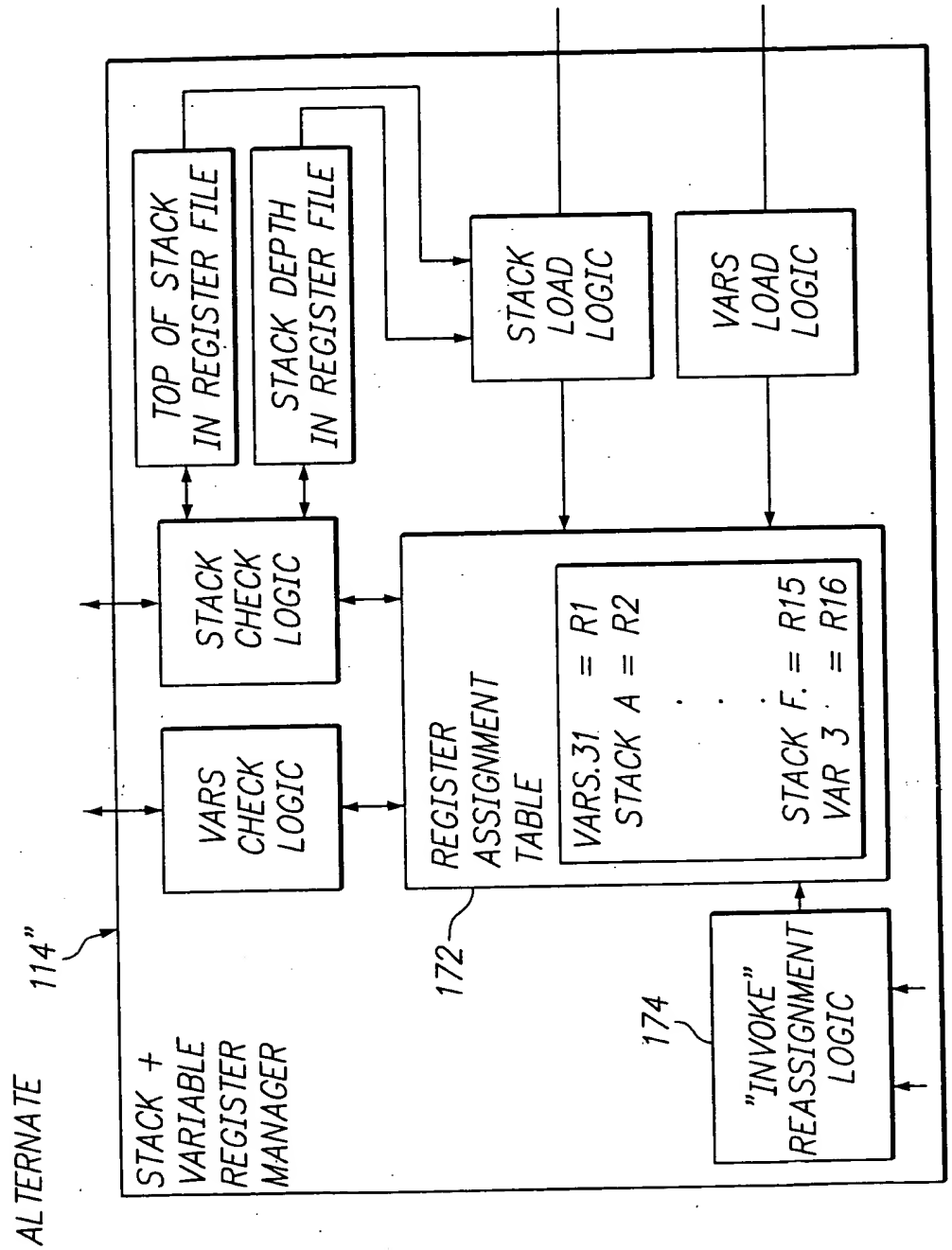



FIG. 16

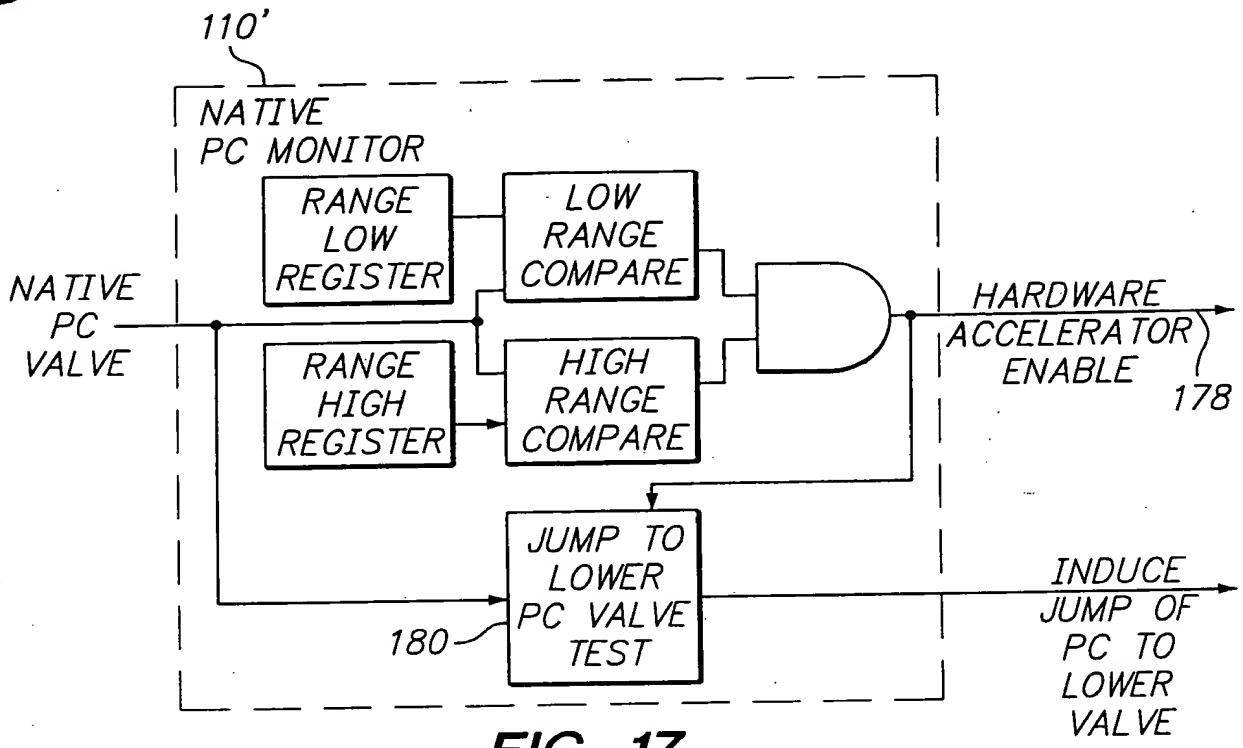



FIG. 17

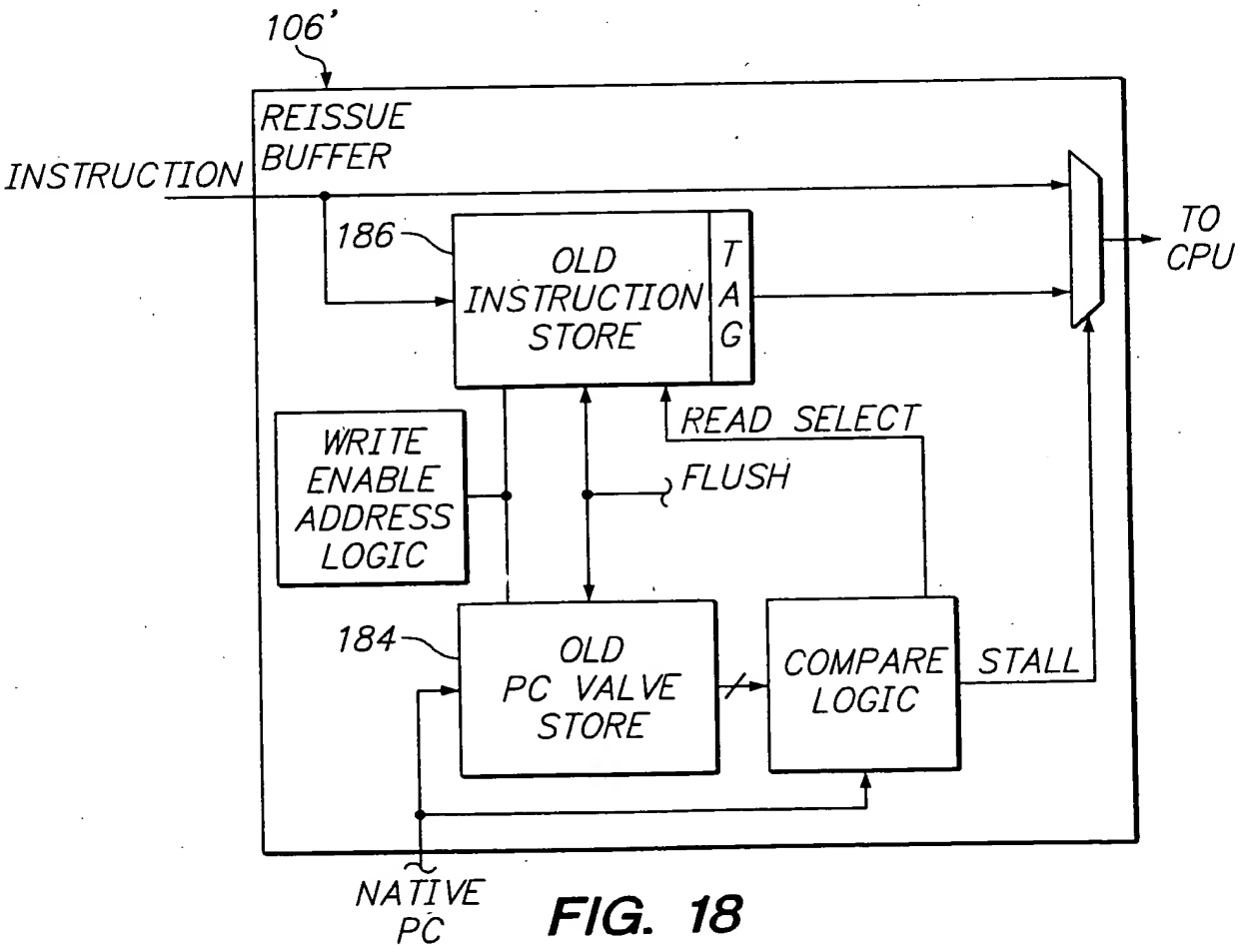



FIG. 18

| | TYPE | COMBINATION | TEST | |
|---|---|---|---|---|
| iload 31 → | LD → | LD | NO | DO LOAD OF VAR 31 FROM MEMORY |
| iload 5 → | LD → | LD | | |
| iadd → | OP → | OP | | |
| istore 8 → | ST → | | | LOAD VAR BASE STORED IN STACK MANAGE INTO TEMP REGISTER R1 |
| | | | | LOAD WORD R1 + 31(x4) PUT RESULT INTO THE TOP OF THE STACK |

FIG. 19

| | | IDEAL TYPE | IDEAL COMBINATION | VARS_TEST | |
|---|---|---|---|---|---|
| BYTECODE A → | iload 3 → | LD → | LD | YES | VARS_H=3 |
| BYTECODE B → | iload 5 → | LD → | LD | YES | VARS_L=5 |
| BYTECODE C → | iadd → | OP → | OP | N/A | OP TYPE=iadd |
| BYTECODE D → | iconst_Ø → | CONST | | | VAR_H CONTROL=01 |
| | | | | | VAR_L CONTROL=01 |
| | | | | | TOS MODIFICATION=1+1−1−1 |
| | | | | | BYTECODES USED=3 |

FIG. 20